

# Management of *Phytophthora capsici* Infection in Black Pepper (*Piper nigrum* L.) using New Generation Fungicides and Biopesticide

Rini, C.R.<sup>1\*</sup> and Remya, J.<sup>2</sup>

<sup>1</sup>Agricultural Research Station, Thiruvalla, Kerala Agricultural University, Kerala, India

<sup>2</sup>Pepper Research Station, Panniyur, Kerala Agricultural University, Kerala, India

\*Corresponding author: [crini@gmail.com](mailto:crini@gmail.com) (ORCID ID: 0000-0001-7531-896X)

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## ABSTRACT

A field study was conducted to evaluate the efficacy of different new generation fungicides and biopesticide against *Phytophthora capsici* in black pepper. Five commercial fungicides and a biopesticide were tested and natural infection due to *P. capsici* was recorded. Disease indexing was done by visual observation on leaf blight, spike infection, leaf shedding and yellowing of vines. Among the different fungicides, spraying and drenching with Fenamidone 10WDG + Mancozeb 50WDG @ 0.2% was found to be the most effective with 12.4% disease intensity. It was followed by Copper hydroxide 77 WP @ 0.2% with 17.8% disease intensity. Dimethomorph 9WP + Mancozeb 60WP and Cymoxanil 8WP + Mancozeb 64WP were also effective against *Phytophthora* infection and found better than the existing practice of spraying Bordeaux mixture and drenching Copper oxy chloride. Soil application of talc based formulation of PGPM mix @ 50 g/vine and foliar spray at 2% concentration also resulted in considerable reduction in the severity of *Phytophthora* infection in black pepper.

## Highlights

- Application of Fenamidone 10WDG + Mancozeb 50WDG or Copper hydroxide 77 WP @ 0.2% during 1<sup>st</sup> week of June, August and October can effectively manage *Phytophthora* foot rot in black pepper
- Other effective fungicides include 0.2% Dimethomorph 9WP + Mancozeb 60WP and Cymoxanil 8WP + Mancozeb 64WP
- Repetitive application of Plant growth promoting microorganisms on to the plant and to the rhizosphere soil will provide better protection against *Phytophthora capsici* in black pepper.

**Keywords:** Black pepper, *Phytophthora* foot rot, new generation fungicides, Biopesticides

Black pepper (*Piper nigrum* L.), the king of spices is a traditional, historic spice crop which has been under cultivation since ancient times in India. Production of black pepper has significantly been affected by foot rot disease caused by *Phytophthora capsici* (Ravindran 2000). Loss of vines due to this disease is generally 5-20% (Manohara *et al.* 2004) which may go even upto 95% loss in individual gardens (Anandaraj *et al.* 1989). *P. capsici* is a polycyclic oomycete plant pathogen against which host resistance is not easily available. Hence an

integrated approach involving cultural, biological and chemical control is necessary for successful management of this disease (Anandaraj 2000). Yet chemical control remained as the main focus of management strategy. Prophylactic application of fungicides such as copper based fungicides, metalaxyl and phosphonates are recommended for foot rot management (KAU, 2011 and Anandaraj 2000). However, continuous application of a single molecule of fungicide like Metalaxyl resulted in emergence of resistant isolates of pathogen (Gisi and



Cohen 1996) and hence combination products like Metalaxyl-Mancozeb are being used (Ramachandran *et al.* 1991). During heavy monsoon contact fungicides like Copper oxychloride do not give satisfactory control of the disease particularly after the onset of disease (KFRI, 1996). Therefore there is a definite need for more fungicides to incorporate into the integrated disease management plan which can bring down the pathogen population in soil and can control leaf, stem, spike, root and collar infections. Several novel fungicides have been developed in the past two decades with known activity against this oomycete pathogen (Thind 2011). Keeping in view the above mentioned facts, the present study was conducted with the objective of identifying technologies including new generation fungicides and biopesticide for managing *Phytophthora* infection in black pepper plantations.

## MATERIALS AND METHODS

The trial was conducted for three years during 2013-14 to 2015-16 at Pepper Research Station, Panniyur. 10 years old black pepper vines of variety Panniyur 1 was chosen for the experiment as this variety is highly susceptible to *Phytophthora capsici*. The treatments included five commercial fungicides viz., Sectin (Fenamidone 10WDG + Mancozeb 50WDG), Acrobat Mz (Dimethomorph 9WP + Mancozeb 60WP), Curzate M8 (Cymoxanil 8WP + Mancozeb 64WP), Bordeaux Mixture 1% + Fytran (Copper oxychloride 50WP), Kocide (Copper hydroxide 77 WP), consortium of Plant Growth Promoting Microorganisms (PGPM) and a control. Consortium of PGPM, a fungal-bacterial mix developed by Kerala Agricultural University consisted of four different microorganisms viz., *Trichoderma viride*, *Trichoderma harzianum*, *Pseudomonas fluorescens* and *Bacillus megatherium*. The experiment was laid out in Randomized block design and each treatment was replicated four times with four plants per replication. The plants were spaced at 4 × 2m, and all agronomic practices as per KAU (2011) were adopted. Spraying and drenching with the fungicides were done during 1<sup>st</sup> week of June (onset of SW monsoon), August (Mid monsoon) and October (onset of NE monsoon) in each year. Natural infection due to *Phytophthora* attack was recorded at monthly intervals for four months of treatment application i.e. July, August, September

and October of all the three years. Disease indexing was done by visual observation on leaf blight, spike infection, leaf shedding and yellowing of vines. Based on the infected area, the experimental plants were rated and had given scores using a score chart of 0-5 scale. On the 0-5 scale, 0 = No infection; 1 = 1-10% infection; 2 = 11-25% infection; 3 = 26-50% infection; 4 = 51-75% infection and 5 = more than 75% infection. Percent disease intensity was calculated using the following formula and statistically analyzed.

Percent Disease Intensity (PDI) =

$$\frac{\text{Sum of all numerical ratings} \times 100}{\text{Total number of leaves observed} \times \text{Maximum disease score}}$$

## RESULTS AND DISCUSSION

Results showed that all the fungicides were significantly superior over control in controlling *Phytophthora* infection in black pepper (Table 1). In 2013-14, application of Fenamidone + Mancozeb, Dimethomorph + Mancozeb, Cymoxanil + Mancozeb and Copper hydroxide were highly effective and superior over control in reducing *Phytophthora* infection on leaves. The disease intensity recorded in unprotected control plants was 30.3% whereas, with the application of these fungicides the intensity of disease was much reduced in the range of 6.7 to 9.3% i.e., around 69 to 78% less than control. Besides, these fungicides were found more effective than the existing recommendation wherein the plants were sprayed with Bordeaux mixture 1% and drenched with Copper oxy chloride @ 0.2%. Application of PGPM also recorded comparatively less disease (24.3%) than the control plants. In 2014-15, plants treated with Fenamidone + Mancozeb and Copper hydroxide @ 0.2% recorded the minimum disease of 10.3 and 11% respectively which was significantly low when compared to control. Application of PGPM was equally effective as that of the above fungicides with 10.7% disease intensity. It was closely followed by the application of Dimethomorph + Mancozeb and Cymoxanil + Mancozeb. The effects of these fungicides and biopesticide were superior to existing practice of Bordeaux mixture spray + Copper oxy chloride

**Table 1:** Percent disease intensity of *Phytophthora* foot rot infection in black pepper garden

Treatments	Percent Disease Intensity*				% reduction over control
	2013-14	2014-15	2015-16	Pooled mean	
T1 Fenamidone 10WDG + Mancozeb 50WDG (spray and drench @ 0.2%)	9.3 (16.9) <sup>c</sup>	10.3 (18.5) <sup>d</sup>	17.5 (24.4) <sup>e</sup>	12.4 (20.4) <sup>c</sup>	63.7
T2 Dimethomorph 9WP + Mancozeb 60WP (spray and drench @ 0.2%)	7.7 (15.8) <sup>c</sup>	13.3 (21.4) <sup>c</sup>	37.1 (37.5) <sup>d</sup>	19.4 (25.0) <sup>bc</sup>	43.3
T3 Cymoxanil 8WP + Mancozeb 64WP (spray and drench @ 0.2%)	6.7 (14.6) <sup>c</sup>	13.0 (21.1) <sup>c</sup>	45.8 (42.6) <sup>bc</sup>	21.8 (26.2) <sup>bc</sup>	36.3
T4 Bordeaux Mixture spray @1% + Copper oxychloride drench @ 0.2%	19.3 (25.7) <sup>b</sup>	15.7 (23.3) <sup>b</sup>	49.6 (44.8) <sup>ab</sup>	28.2 (31.4) <sup>ab</sup>	17.5
T5 Copper hydroxide 77 WP (spray and drench @ 0.2%)	8.3 (16.5) <sup>c</sup>	11.0 (19.3) <sup>d</sup>	34.2 (35.7) <sup>d</sup>	17.8 (23.9) <sup>bc</sup>	48.0
T6 PGPM spray @ 2% + soil application @ 50g vine <sup>-1</sup>	24.3 (29.3) <sup>ab</sup>	10.7 (19.0) <sup>d</sup>	40.0 (39.2) <sup>cd</sup>	25.0 (29.3) <sup>ab</sup>	26.9
T7 Control	30.3 (33.2) <sup>a</sup>	18.0 (25.1) <sup>a</sup>	54.2 (47.4) <sup>a</sup>	34.2 (35.3) <sup>a</sup>	
CD (P<0.05)	4.5	1.6	3.7	8.1	

Figures in parenthesis are arc sin transformed values.

\*Mean of four months

drench similar to the previous year's result. Disease severity during 2015-16, was comparatively higher than the previous years. However a similar trend in disease control was noticed with the fungicides tested recording minimum infection in the treatment with Fenamidone + Mancozeb having percent disease intensity (PDI) 17.5% followed by Copper hydroxide (PDI 34.2%) and Dimethomorph + Mancozeb (PDI 37.1%). Application of PGPM also recorded very less infection (PDI 40%) which was better than Bordeaux mixture spray + Copper oxy chloride drench (49.6% PDI) and the untreated control (54.2% PDI). Pooled analysis of the three year data revealed that, all the tested fungicides reduced the disease significantly as evidenced by the lower PDI. In all the three years, the best treatment observed was Fenamidone + Mancozeb which reduced the disease by 63.7% than the control. Next best treatment observed was Copper hydroxide which resulted in 48% less disease than the control. Dimethomorph + Mancozeb and Cymoxanil + Mancozeb were found better than the existing recommendation of Bordeaux mixture spray and Copper oxy chloride drench and was statistically on par with Copper hydroxide. The effect of Bordeaux mixture and copper oxy chloride in *Phytophthora* foot rot management is well documented (Ramachandran *et al.* 1991; Anandaraj and Sarma 1995., KAU, 2011.)

and the package has been widely adopted in Kerala. However a number of new fungicide molecules with different mode of action have been evaluated and reported against different species of *Phytophthora* (Anjaneya *et al.* 2015; Padmaja *et al.* 2015). Michael and Martin (2008) reported better survival of pepper plants in soil infested with *P. capsici* when soil was treated with Reason (fenamidone) + Previcur Flex (propamocarb) and Dimethomorph. In the present study, soil application of consortium of PGPM @ 50g/vine + spraying @ 2% concentration which was repeated twice during the season also resulted in considerable reduction in the severity of *Phytophthora* infection in black pepper. Similar report on use of biocontrol agents in combination for better disease control was made by Anith and Manomohandas (2001) and Manoranjitham *et al.* (2001). The fungal – bacterial combination may exert any of their antagonistic mechanisms individually or more than one of them acting simultaneously in synergistic manner for better disease suppression.

## CONCLUSION

The data from this study suggest that fungicides like Fenamidone 10WDG + Mancozeb 50 WDG (Sectin), Copper hydroxide 77 WP (Kocide), Dimethomorph 9WP + Mancozeb 60 WP (Acrobat Mz) and Cymoxanil 8WP + Mancozeb 64WP



(Curzate M8) that are not currently used in black pepper could be included as effective components of a management program against *Phytophthora capsici*. It is well clear that repetitive application of Plant growth promoting microorganisms on to the plant and to the rhizosphere soil will helps in providing better protection against the dreadful plant pathogen *Phytophthora capsici* in black pepper.

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